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The Behavioral Effects of Crowding: Definitions and Methods*

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Abstract

Crews of 18 U.S. Navy combat vessels rated their living and working conditions aboard ship, including degree of crowding. In order to better understand the behavioral effects of crowding, three different types of measures, corresponding to different definitions of crowding, were constructed. These separate crowding measures correlated uniquely with satisfaction and illness criteria.

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The Behavioral Effects of Crowding: Definitions and Methods*

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Recently there has been increased concern among the public and within professional ranks over the potential effects of crowding on people (Schaar, 1975). A review of the literature on crowding has shown an inconsistent pattern of results relative to the effects of crowding on humans. For example, negative effects of crowding on certain behaviors have been reported by some (Griffitt and Veitch, 1971; Dooley, 1974), while positive effects on related behaviors have been noted by others (Loo, 1972). Finally, some investigators have reported finding no significant relationships between various observed behaviors and crowding (Freedman et al., 1971). Noting these discrepancies, efforts have been made to begin model or theory building in this area (Desor, 1972; Stokols, 1972a, 1972b, 1974; Evans and Eichelman, forthcoming). However, the only agreement to be found among these formulations is that more empirical research is needed. As Griffitt (1974) has noted: "Perhaps a bit more empirical consistency would be desirable prior to attempts to achieve conceptual consistency."

The apparent inconsistency of research results in this area might be

attributed to numerous factors including: (a) the paucity of relevant human crowding research (Lawrence, 1974; Schaar, 1975); (b) the seemingly inappropriate settings that have been used for crowding research, and (c) the methodological difficulties and confusion that seem to arise from inadequate definitions (Griffitt, 1974; Lawrence, 1974). In order to investigate more fruitfully the behavioral effects of high population density, full consideration was given to each of the foregoing factors. First, subjects of this investigation were studied in a natural setting in which they lived and worked 24-hours a day and in which confinement was a salient quality of the environment. Secondly, the correlates of three separate crowding measures which correspond to three different definitions of crowding were compared and contrasted in order to better understand each measure. Two of these definitions -- density and individual perceptions of crowding -- have been used extensively by researchers who refer to both as crowding, although they are conceptually different. Density, as measured by number of persons per square kilometer, has been used to study the effects of crowding on health and social adaptation (Levy and Herzog, 1974). The importance of individual perceptions and learning in assessing crowding is shown by the cross-cultural work of Hall (1966) who found significant cultural differences regarding space requirements. Not only are physical boundaries important with respect to crowding, but the subjective evaluation of the boundaries also is important. In the present study measures of density and perceived crowding were used. In addition, a third variable was developed to measure the degree to which perception of crowding was a function of situational factors beyond density.

METHOD

Subjects

Enlisted men from 18 ships rated living and working conditions aboard their own ships by responding to a Habitability and Shipboard Climate Questionnaire (HQ); approximately 70% of the ships' complements were tested. Four types of ships included in the study were three destroyers (DD), six missile destroyers (DDG), three missile frigates (DLG), and six destroyer escorts (DE). All individuals (N = 2,898) with complete data for the analyses, that is, men with valid questionnaire answer sheets, department and division information, and illness data were arbitrarily divided into validation (N = 1,450) and cross-validation (N = 1,448) subsamples.

Procedure

Crowding Measures. Three types of crowding measures were created for each subject. The first type was actual physical size measurements of the ships compiled by ship type because all ships within a type were virtually identical with respect to structural characteristics. The physical size data that were used included length, beam, draft, and design complement (Blackman, 1973). A density score (volume of space per man) was created for each ship type. Volume per man was computed by dividing the product of length, beam, and draft by the designed complement. This volume per man score was then assigned to each man in the study according to his ship type.

The second type of measure, individual perceived crowding, was the summed score of seven items from the HQ describing crowding in specific areas aboard ship (messing or dining areas, heads or sanitary facilities, and the

ship in general). These items referred to the amount of space available (cramped to roomy) and the number of people (crowded or uncrowded) occupying the areas specified above. Subjects responded to these dimensions on 5-point rating scales. One additional 3-point scale that ranged from "tight and cramped" to "adequate room" was included in this measure of ship crowding. Individual ratings of crowding that were controlled for ship differences were constructed by subtracting ship mean scores from individual ratings.

The third type of measure of crowding consisted of "situation effect" (frequency-weight) measures (Kendall and Stuart, 1966). These were the mean ratings of crowding per ship and ship type for individuals in the validation sample. A prior study showed that ship type scores and ship within type scores (differences between ship type and ship mean scores) each contributed significantly and uniquely to individual ratings of crowding (Pugh, Gunderson, and Dean, 1975). Because these situations in some way tended to elicit a common experience of crowding, ship type means were used to measure the experience engendered by type of ship and differences between ship means and ship type means were used to measure the experience engendered by individual ships.

Criteria. The behavioral criteria used in this study included four satisfaction measures and total illness rate. An overall satisfaction scale consisted of a composite of HQ items utilized in previous studies (Dean, Pugh, and Gunderson, 1975). This brief scale was shown to have adequate reliability and to correlate substantially with the Smith Job Descriptive

Index (Smith, Kendall, and Hulin, 1969). A habitability satisfaction scale was based on responses to the item, "Choose the number that most nearly describes how satisfied you are with conditions in general for each of the shipboard areas mentioned below." (These included five specific areas: messing areas, berthing areas, heads or sanitary facilities, working areas, and the ship in general.) A Navy satisfaction scale was based on responses to a single HQ item concerned with satisfaction with the Navy in general. A job satisfaction (need) scale was based on responses to 17 HQ items concerned with specific aspects of an individual's job (Porter, 1961). Total individual illness rates were computed by calculating the total number of initial dispensary visits for each individual during his ship's overseas deployment.

RESULTS

The physical size measurements, the design complements, the created density scores, and the perceived crowding scores for the ships by the four ship types are shown in Table 1. It can be seen in Table 1 that perceived crowding by ship type parallels the density scores; the high density ship types are perceived as being more crowded.

(Insert Table 1 about here.)

The interrelationship among size, density, and perceived crowding measures are shown in Table 2. It can be seen that individual ratings of perceived crowding can be separated into three unique components or ship effect scores: a ship type portion, a ships within ship type portion, and an individual within ship portion. The correlation of these scores with the raw perceived crowding score is a measure of the contribution of each to the

individual ratings of crowding. Both ship type and ships within type correlated significantly with perceived crowding, $F(3,1432) = 87.67$, $p < .01$ and $F(14,1432) = 2.09$, $p < .05$, respectively. Table 2 also shows that the density measure -- volume per man -- correlated better with perceived crowding than any of the size measures. Furthermore, volume per man appears to be virtually identical with the ship type crowding measure because both measures account for approximately the same amount of perceived crowding variance and are highly correlated with each other. Thus, the communality of perception or experience of crowding among men within ship type appears to be entirely due to physical density.

(Insert Table 2 about here.)

If the ship type effect can be equated to density, then the ships within type score must be that portion of the perception of crowding which is a function of the situational factors beyond density. The three types of measures of crowding created in this study, and their correspondence to three views or definitions of crowding are shown in Table 3. Our analyses to this point demonstrate that each one of these measures corresponds to three different definitions of crowding. These measures were then correlated with the criteria and different patterns of correlations resulted depending upon the measure or definition used. These correlations are shown in Table 4.

(Insert Table 3 and 4 about here.)

The correlations of the crowding measures with illness and satisfaction criteria are shown in Table 4. It can be noted that more space per man tended to be associated with a lower total illness rate, but correlations were low.

It is also apparent that dense areas were rated low on habitability satisfaction, but this relationship was not present for the other satisfaction criteria. Perceived crowding at the individual level relates to all of the satisfaction criteria. This would be anticipated because satisfaction measures are a function of individual needs and perceptions which also affect habitability ratings (Schneider, 1973).

Selected correlational values from Table 4 for the validation sample are shown in Table 5 in order to make more explicit the diversity of results obtained in one study when different definitions and measures of crowding were used. It can be seen that of the four variables shown only one, habitability satisfaction, has consistent correlations among the three crowding definitions. This result should not be surprising because these definitions are intended to represent three separate components of "crowding." The independence of these measures (variables 5, 7, and 8) was demonstrated in Table 2 where they intercorrelated zero or near zero.

(Insert Table 5 about here.)

DISCUSSION

In the past many attempts have been made to measure crowding in a variety of settings and to relate these measures to various behavioral criteria. In each of these studies the researchers attempted to define what crowding is and just how it should be measured, but in many instances it appeared that the specific purpose or objective of the investigators determined the measurements and definitions of crowding that were used. One common view implies a physical definition of crowding and psychological effects or criteria. For

example, a person's well-being may be studied as a function of density. Another view assumes a psychological definition of crowding and an objective behavioral criterion; that is, performance may be studied as a function of the perception or feeling of crowding. Thus, it is no wonder that results of studies based upon the first view are totally different from results of studies based upon the second view. The particular measure of crowding used in a study implies a specific definition of crowding. This is to say that variables with different meanings will have different patterns of correlation with the same criterion variables, a conclusion that is substantiated by the present results. In crowding research one must decide whether to use the variable that carries the proper meaning (if the proper meaning is known) or to use the variable with the greatest utility in predicting a particular criterion.

Our view follows our specific notions of what crowding should mean. It is that crowding is an experience induced by environmental conditions, but this experience requires human perception in order for it to be measured. In the present study, two variables represented this concept of crowding. One was the density measure. This was the portion of perception directly related to a particular feature of the environment. The other was the ships within type component of perceived crowding. This component requires the response of subjects in order for it to be measured.

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Footnotes

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Table 1

Physical and Perceptual Measures of Size, Density, and Crowding by Ship Type

Ship Type	Physical Size Measures			Designed Enlisted Complement	Density or Volume/Man[a]	Perceived Crowding[b]
	Length	Beam	Draft			
Destroyers (DD)	390	41	19	260	1168	12.24
Guided Missile Destroyers (DDG)	437	47	20	330	1245	13.73
Guided Missile Frigates (DLG)	547	55	28	387	2177	15.59
Destroyer Escorts (DE)	438	47	25	205	2510	17.23

[a]Length X Beam X Draft ÷ Designed Enlisted Complement.

[b]Higher score indicates less crowding.

Table 2

Intercorrelation of Physical and Perceptual Measures of Size, Density, and Perceived Crowding

	Physical Size Measures				Density Measure	Perceived Crowding Components			Perceived Crowding Raw Score
Variables	1	2	3	4	5	6	7	8	9
1. Length	1.00								
2. Beam	.98	1.00							
3. Draft	.84	.83	1.00						
4. Designed Complement	.70	.66	.19	1.00					
5. Density or Volume/Man	.46	.49	.87	.31	1.00				
6. Ship Type	.39	.47	.78	-.35	.96	1.00			
7. Ships Within Type	-.12	-.11	-.09	-.09	-.04	-.04	1.00		
8. Within Ship	.00	.00	.00	.00	.00	.00	.00	1.00	
9. Perceived Crowding Raw Score	.14	.17	.29	-.15	.37	.39	.13	.91	1.00

N = 1,450

Table 3

Three Definitions of Crowding and Corresponding Measures

Three Types of Measures	Definitions of Crowding: Density	Situational Factors Beyond Density	Individual Differences
I. Physical:			
Size Volume/Man	Volume/Man		
II. Perceived Crowding:			
Individual Ratings of Crowding (X)[a]			Individual Ratings of Crowding (X)[b]
III. Situation Effects:[a]			
Ship Type ($\overline{X}_t$)	Ship Type ($\overline{X}_t$)		
Ships Within Type ($\overline{X}_s - \overline{X}_t$)		Ships Within Type ($\overline{X}_s - \overline{X}_t$)	
Individuals Within Ship ($X - \overline{X}_s$)			Individuals Within Ship ($X - \overline{X}_s$)

[a] $(\overline{X}_t) + (\overline{X}_s - \overline{X}_t) + (X - \overline{X}_s) = X$, where, $\overline{X}_t$ = ship type effect, $\overline{X}_s$ = ship effect, and X = raw score.

[b] Note that where individual ratings (X) are made for specific ship areas, the $(\overline{X}_t)$ and $(\overline{X}_s - \overline{X}_t)$ terms do not exist; therefore when external variables are held constant, individual ratings (X) are direct measures of individual differences.

Table 4

Correlation of Crowding Measures with Illness and Satisfaction Criteria

Validation Sample (N = 1,450)

	Situation			Individual	
Category	Volume/Man	Ship Type	Ships Within Type	Within Ship	Raw
Total Illness Rate	-07*	-04	-01	01	01
Habitability (Composite)	28**	29**	11**	52**	60**
Overall (Composite)	00	01	07*	21**	21**
Navy (Single Item)	-04	-02	03	22**	19**
Job (Composite)	-02	-02	11**	29**	27**

Cross-Validation Sample (N = 1,488)

Total Illness Rate	-04	-01	01	-08*	-08*
Habitability (Composite)	25**	27**	05	52**	61**
Overall (Composite)	-03	-02	01	16**	14**
Navy (Single Item)	-02	00	00	20**	19**
Job (Composite)	-03	-02	02	28**	25**

*$p < .05$

**$p < .01$

Table 5

Correlation of Three Measures of "Crowding" with

Illness and Satisfaction Criteria

Category	Density	Individual Differences	Situational Factors Beyond Density
Total Illness Rate	-07	01	-01
Habitability Satisfaction	28	52	11
Navy Satisfaction	-04	22	03
Job Satisfaction	-02	29	11